NOTES ON THE BIOLOGY AND CONTROL OF CHRYSOPS DISCALIS WILLISTON (Diptera, Tabanidae)

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INTRODUCTION

The deer fly *Chrysops discalis* was named by Williston (*5*) in 1880 from specimens collected in Wyoming. It has since been taken in Oregon, Washington, Idaho, California, Nevada, Colorado, Utah, Montana, North Dakota, Minnesota, and Nebraska. Hearle (*4*) states that in Canada it is "especially common in the Dry Belt of British Columbia and extends as far east as Manitoba . . ." In 1921 Francis (*3*) proved that this species was the carrier of tularaemia, and reported a number of cases of the disease in Utah. In 1937 Francis (*2*) reported the seasonal and geographical distribution of 67 cases of tularaemia that had been transmitted by this fly in the United States from 1924 to 1935. Thirty-eight of these cases occurred in Utah. Cameron (*1*) obtained the larvae of *C. discalis* "on 29th June 1925 amongst decaying vegetable matter washed up on the shore by the strongly alkaline waters of Baldur Lake in Southern Manitoba." He found that the larvae did not feed on each other and could be reared in soil containing considerable organic material.

In Oregon *Chrysops discalis* has been taken in Lake County in the vicinity of Summer Lake and Abert Lake, and in Warner Valley. Specimens have also been taken in Klamath County near Klamath Falls, in Harney County near Frenchglen, and in Jefferson County near Warm Springs.

Chrysops discalis (fig. 1) is a severe pest of cattle, horses, and humans on dairy and cattle ranches bordering Summer Lake. In the more heavily infested areas 25 or more flies swarm continuously around the heads of the men working in the hayfields. Large numbers swarm around the cattle and horses and feed on them. Live-stock in this area is also attacked by *Tabanus productus* Hine, *T. sonomensis phaenops* O. S., and *T. punctifer* O. S., but these species are less numerous than the deer flies.

Summer Lake is about 16 miles long by 6 miles wide, and lies in a valley about 25 miles long by 15 miles wide, which is almost entirely surrounded by hills. Deer flies are present in the

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valley from the middle of June to the first part of September. They have been found to be fairly numerous from 4 to 5 miles from their breeding places.

A number of cases of tularaemia occur in the valley almost every year. The first case was reported to have occurred 28 years ago. There were six cases in 1943, and none in 1944. Rabbits, which are reservoirs of the disease and normally numerous in the valley, were nearly all destroyed by an epizootic in 1943. In 1921 Francis (*3*) reported the coexistence of human cases and a fatal epizootic in rabbits in Utah, both of which were caused by (*Bacterium*) *Pasteurella tularensis*, the causative organism of tularaemia. The destruction of the rabbits in the Summer Lake area was undoubtedly also caused by tularaemia, and the absence of human cases in this area in 1944 was apparently due to the reduction in the number of rabbits.

Tests to determine whether sprays containing DDT (1-trichloro-2, 2-bis (p-chlorophenyl) ethane) might be effective in protecting cattle in this area from *Chrysops discalis* were made during the summer of 1944. A few tests on the effect of this insecticide against newly hatched larvae were also made in the laboratory. Information on the biology of the species was also obtained during the summer.

NOTES ON BIOLOGY

The water in Summer Lake is maintained by a river arising from large springs about 4 miles from its northern end. A dam has been built across this river to provide water for irrigation in the valley. Rest Lake and several ponds are scattered around the flat areas bordering the northern half of the lake. Summer Lake has no outlet, and is shallow over most of its area. It is approximately 2 feet deep in the deepest place.[2] During the summer months the water level falls several inches, and alkali flats from a quarter of a mile to a mile or more in width are exposed. Grass and sagebrush border these alkali flats.

The waters of Rest Lake and Summer Lake are highly alkaline. A sample of water from Summer Lake having 21,730 parts per million (p. p. m.) of total solids was found to contain about 67 percent of sodium carbonate, 18 percent of sodium chloride, 13 percent of sodium sulfate, and about 2 percent of other salts. Mud from Rest Lake had a pH of 8.8 and that from Summer Lake a pH of 9.6. Mud samples from both lakes contained large amounts of hydrogen sulfide. The concentration was somewhat higher in the Summer Lake sample. The

[2] The contours of the Summer Lake bottom were mapped by the U. S. Geological Survey in 1941. In June of that year, when the water level was estimated to be slightly below normal, the water was 1.5 feet deep in the deepest place across from Hunters Point.

hydrogen sulfide apparently comes from the spring water, which flows into the lake.

In the Summer Lake area larvae of *Chrysops discalis* were first obtained on July 18 from a small pond near the northern end of the lake. The larvae were recovered from mud samples taken at intervals from a point 25 feet out in the pond to the shore, under water from 1 to 2 feet deep and from 2 to 4 inches under the surface of the mud. They were obtained by washing the mud through a 16-mesh sieve. These larvae were from 13 to 17 millimeters long.

Larvae were also obtained from Rest Lake at this time. An average of two larvae per pint dipper of mud were found 100 feet from shore, where the water was about 6 inches deep. Closer to the shore the larvae were more numerous. They were of the same size as those found at Summer Lake, and were taken at the same depth in the mud.

The shore of Rest Lake slopes upward gradually for a distance of 3 to 10 feet to a grassy bank about a foot high. Pupae and pupal cases were found in large numbers just below the edge of this bank, where the soil was comparatively dry. The cases protruded about three-eighths of an inch above the soil, and averaged 3 or more per square inch in emergence beds of considerable size. It was estimated that 90 percent of the flies had emerged from this area by July 22. The emerging flies pushed out of their pupal cases and rested on top of them or on the ground while their wings hardened. Pupal cases left by *Chrysops discalis* emerging from this area are shown in figure 2.

Larvae, pupae, and cast skins were also found in several places around the southern end of Summer Lake. In most instances both the larvae and the pupae were from 50 feet to several hundred yards from the water, and from 50 yards to half a mile or more from any type of vegetation. These areas had apparently been under water earlier in the season, but had been gradually exposed as the water level fell.

A large number of larvae from Rest Lake were brought to the laboratory and confined in individual containers, where seven of them pupated and emerged. The length of the pupal stage ranged from 5 to 9 days.

Several *Chrysops discalis* larvae about 6 millimeters long were found floating on the surface of Rest Lake, when this area was visited again on August 25. These larvae were found near the shore.

Chrysops discalis egg masses were also found at this time on the stems of *Scirpus americanus* Pers., a sedge which grows in small patches along the shore of Rest Lake. The eggs, which are cemented to the stems and to each other, are shown in figure 3. They were concentrated on small clumps of sedge growing near the water line of the lake. The number of eggs in each of 5

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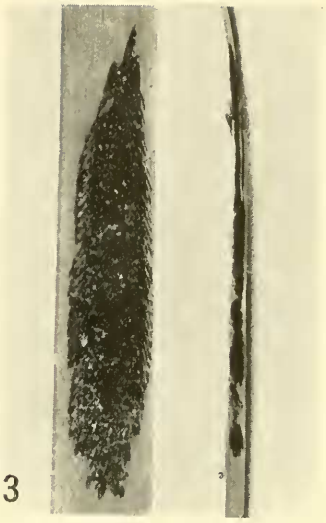

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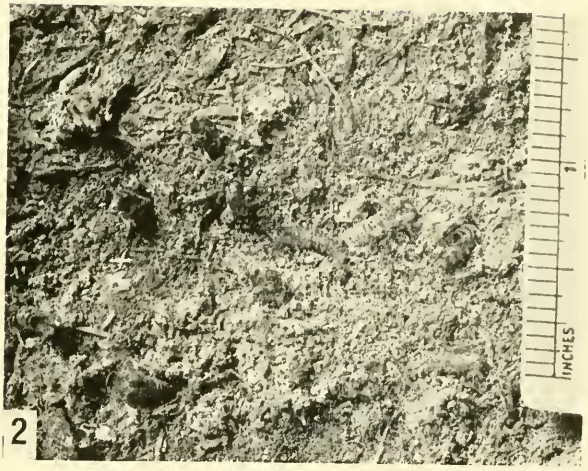

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Fig. 1. The deerfly *Chrysops discalis* Williston; female at left and male at right. X 1.4.

Fig. 2. Pupal cases of *Chrysops discalis Williston* projecting from soil on shore of Rest Lake, Ore., where this species emerged in large numbers.

Fig. 3. Eggs of *Chrysops discalis* Williston laid on stems of *Scirpus americanus* Pers. Egg mass on left, X 4.7; egg masses on right, X 0.7.

different egg masses ranged from 179 to 500, the average being 356. Many stems had 25 or more such egg masses, or a total of 9,000 or more eggs per stem. Only occasionally were egg masses found that had hatched.

One female was observed while laying eggs on a *Scirpus americanus* stem. She was facing downward on the stem, and had laid approximately 450 eggs. A considerable number of the eggs were still grayish white, and they did not turn black until about 18 hours later. All the eggs hatched 5½ days after they were laid.

All the larvae from one egg mass usually hatched in 2 to 10 minutes after hatching began. Newly hatched larvae that were placed on water over mud remained on the surface of the water part of the time. The larvae passed through their first molt about an hour after they had hatched.

The northern half of Summer Lake is overgrown with *Scirpus paludosus* A. Nels. Small areas of *S. americanus* grow along the borders of this sedge. In all the examinations made *Chrysops discalis* egg masses were found only on *S. americanus*. In the southern end of Summer Lake no vegetation is present, and there appears to be no place for large numbers of flies found in that section to lay their eggs, unless they lay them on the mud or water or fly to the nearest clumps of sedge.

All egg masses found on *Scirpus americanus* plants in August had hatched when the Summer Lake area was visited again on October 18. The larvae were from 3 to 9 millimeters in length. They were obtained by placing mud samples on a piece of cheesecloth, gathering up the edges to form a bag, and agitating this bag in water until the fine mud was washed out. The larvae could be seen in the coarse residue that remained.

Larvae from eggs laid in 1943, as well as in 1944, were found in Rest Lake. Only a few large larvae were found. These would probably require 2 years to complete their life cycle, since they were still some distance out in the mud of the lake. Small larvae were present in samples taken from within 25 feet of the shore of this lake. In Summer Lake small larvae were found in the mud near the water and out as far as 30 feet. Larvae are probably also present farther out in these lakes. The larvae were taken 1 to 3 inches beneath the surface of the mud under 2 to 6 inches of water. In one area that was sampled for larvae in Summer Lake, the nearest vegetation was 400 yards from water. In another area the nearest vegetation was separated from shore by 400 yards of dry alkali flat, and the *Scirpus americanus* plants nearest the water were half a mile away.

The presence of these small larvae in areas so distant from the known areas of egg deposition, as well as the presence earlier in the summer of full-grown larvae and pupae half a mile or

more from vegetation of any kind, indicates either that the flies of this species lay their eggs on the mud or water, or that the larvae are carried to these locations by waters of the lakes or ponds in which they are found. Both newly hatched larvae and larvae 6 millimeters long have been observed to float on the surface of the water. The length of time they float has not been determined, but if larvae remained floating for some time they could be readily distributed from the northern end of Summer Lake, where most of the eggs were found, to the southern end of the lake by the continuous inflow of water into the northern end and also by the strong winds that blow from the north during the evenings.

Eggs of this species might also be laid in the cracks in the mud of alkali flats, which are exposed when the lake waters recede during the summer. This would explain the presence of larvae so far from the sedge plants on which the eggs have been found. However, it seems doubtful that an insect which cements its eggs on a plant would also lay its eggs on the soil.

EFFECT OF DDT ON ADULT AND LARVAL STAGES

Tests of DDT sprays were made in Summer Lake Valley in July. Out of a total of 34 milk cows on 4 ranches, 13 cows were sprayed with DDT emulsion, 12 with 2 percent DDT and 1 with 4 percent DDT. The sprays were made up from a stock emulsion containing 25 percent of DDT, 68 percent of xylene, and 7 percent of Triton X-100 (an aralkyl polyether alcohol). The emulsion was applied as a fine spray with a 5-gallon knapsack sprayer. For application around the head and eyes a cloth was soaked in the liquid. Approximately a half-gallon of emulsion was used per cow, sufficient to wet the animal thoroughly.

The number of flies attacking the cattle ranged from almost none on 1 ranch to about 50 per animal on others. The spray was applied in the morning, after the cows had been milked, and its effect was usually observed in the forenoon and again in the afternoon. The flies swarmed around both the sprayed and unsprayed animals, and fed mostly around their heads and shoulders. There was no noticeable reduction in the number of flies alighting and feeding on the sprayed animals. Flies that were not disturbed or driven off by the animal usually remained for several minutes.

In order to observe the effect of DDT on deer flies more closely, some of the flies were captured in the sagebrush, confined for periods of 2, 5, 10, and 15 minutes in pint glass jars which had been coated with DDT, and then transferred to clean jars. The jars were coated by filling them with a 2 percent DDT emulsion, draining them, and then letting them dry thoroughly. Observations made 30 minutes after the exposure periods indi-

cated that all the insects were unable to fly. Flies exposed for 2 and 5 minutes were dead at the end of 8 hours, and 90 percent of those exposed for 10 and 15 minutes were dead in 4 hours.

Chrysops discalis requires several minutes to obtain a full blood meal, and the legs, undersides, and mouthparts of flies feeding on sprayed animals would be in contact with DDT during this time. The tests with flies in DDT-coated jars indicate that all flies feeding on sprayed animals would eventually be killed. It is doubtful, however, that much relief would be obtained in the Summer Lake area, even if all the cattle in the valley were sprayed, for there are large areas of sagebrush that are heavily infested with flies and comparatively few cattle.

Horn flies were also present on the cattle sprayed in these tests. DDT was apparently effective against these flies, since very few were seen after the cattle were sprayed.

A few tests were also made of 2 percent DDT emulsion against first and second instars of *Chrysops discalis* larvae in tap water. This emulsion was made up from the same type of stock emulsion that was used in the previous test. The larvae were tested in 4 liters of tap water in glass jars. Results of these tests are shown in table 1. In these tests 25 larvae were used in each jar, but larvae which were first affected by the poison were apparently eaten by the remaining live larvae. This may have affected the mortality, but the tests indicate that all larvae would probably be destroyed by a 1 p. p. m. concentration of DDT, even if dead larvae were not eaten by the temporary survivors.

TABLE 1. The toxicity of 2 percent DDT emulsion to first and second instars of *C. discalis* (2 replications of 25 larvae each)

Millions of parts of water to 1 part DDT	Percent Mortality in	
	24 hours	48 hours
1	60	100
5	48	98
10	20	72
No DDT	0	0

SUMMARY

The deer fly *Chrysops discalis* Williston is a severe pest of cattle, horses, and man in the Summer Lake Valley in Oregon. Several cases of tularaemia are also caused by the bite of this fly almost every year.

The waters of Summer Lake and Rest Lake, where most of the flies breed, are highly alkaline, the pH ranging from 8.8 to 9.6,

and the mud is saturated with hydrogen sulfide. In July larvae of *Chrysops discalis* were obtained in mud samples taken as far as 100 feet from shore, under water up to 2 feet deep. The larvae were about 16 millimeters long, and were buried from 2 to 4 inches in the mud. Many larvae and pupae were present in the soil bordering the lakes, and many flies had emerged.

Large numbers of eggs were found on the stems of *Scirpus americanus* Pers. on August 25, but none were found on other plants. All these eggs had hatched by October 18, and the larvae, which were from 3 to 9 millimeters in length, were found in mud samples taken at intervals from a point near the shore to 30 feet out in the lake. Large larvae obtained in July, as well as small larvae obtained in October, were found a half mile from vegetation of any kind, and since the larvae have been found to float on the surface of the water at times, they may have been carried to these places by water currents or wave action. The eggs of *Chrysops discalis* hatch 5 or 6 days after they are laid, and the larvae molt about an hour after they have hatched. The pupal stage requires from 5 to 9 days.

Cattle were sprayed with 2- and 4-percent emulsions made from a stock emulsion containing 25 percent of DDT, 68 percent of xylene, and 7 percent of Triton X-100 (an aralkyl polyether alcohol). Application of one-half gallon per animal did not noticeably reduce the number of flies attacking the cows. In laboratory tests flies that were confined in glass jars coated with a 2 percent DDT emulsion for 2 minutes and then transferred to clean jars were killed in 8 hours, while those confined in coated jars for 10 minutes and then transferred were killed in 4 hours.

The same type of emulsion was tested against first and second instars of *Chrysops discalis* in water. In these tests 1 part of DDT to 10 million parts of water caused a mortality of 72 percent in 48 hours, and 1 part of DDT to 5 million parts of water caused a mortality of 98 percent in 48 hours.

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